

Amendments to the Specification

Please replace the paragraph [0014] on Page 3 of the specification as filed with the replacement paragraph set out below.

[0014] As described in U.S. Patent 4,269,791, which is incorporated herein by reference, the hydrogen and oxygen are mixed at a ratio of 95:5 H₂-O₂ H₂-O₂ through turbulent liquid media for diving applications where the mixing primarily occurs through gas diffusion in liquid phase, not through gas bubble interactions by coalescence and breakage. The bubble sizes described in U.S. Patent 4,269,791 are very small [in the range of 50 to 100 micron (μm)], and do not induce massive liquid turbulence. Therefore, U.S. Patent 4,269,791 discloses the use of a pump to recycle the liquid to generate liquid turbulence.

Please replace the paragraph [0020] on Page 5 of the specification as filed with the replacement paragraph set out below.

[0020] The tank may also include heat exchange tubes, or other means for providing a control of liquid temperature in order to preheat the reactant gas to control liquid vaporization for use in a reactor, and/or to vary the solubility of components in the feed gases into the liquid.[[.]]

Please replace the paragraph [0046] on Pages 9-10 of the specification as filed with the replacement paragraph set out below.

[0046] Figure 3 shows one embodiment of mixing tank 230 filled with a liquid. A hydrocarbon gas, supplied by stream 240, is injected into tank 230 through distribution system 260. An oxygen-containing gas, supplied by stream 250, is injected into tank 220 through distribution system 270. Distribution systems 260 and 270 may be any arrangement of sparging rings, nozzles, inlets, or any combination thereof as may be useful to inject the feed gases in a desired concentration and distribution. As the hydrocarbon and oxidant gas bubbles travel through the

liquid, turbulence within the liquid volume causes the bubbles to collide with each other. These collisions cause the ~~bubble-bubbles~~ to repeatedly coalesce into larger bubbles and then break-up into smaller bubbles. It is this cycle of coalescing and breaking-up that mixes the hydrocarbon gas and the oxidant gas such that, by the time the gas bubbles reach the top of tank 230, the ~~gas-is~~ gases are fully mixed in the desired ratio. A desirable residence time for the gas bubbles in the liquid phase is greater than 1 second, preferably between 2 seconds and 20 minutes. Since there ~~is-are~~ sufficient collision/coalescence/breaking events of the bubbles to cause a change in bubble size over the length of the gas-expanded bed, the type of gas distribution system 260 and 270 employed in delivering the feed gases is not critical.

Please replace the paragraphs [0052]-[0055] on Pages 12-14 of the specification as filed with the replacement paragraphs set out below.

[0052] The repeated coalescence and break-up of bubbles is the mechanism relied on for mixing the feed gases into the desired reactant gas. Thus, the frequency with which the individual bubbles collide, coalesce, and break-up is critical to the preparation of the desired reactant gas. The frequency of collision, coalescence, and break-up is partially determined by the turbulence created within at least a region of the liquid volume. Turbulence in at least a region of the liquid is caused by the combined gas flow of the plurality of gases, preferably corresponding to a total gas superficial velocity between about 5 and 60 cm/sec, more preferably between ~~[[10-60]]~~ 10 and 60 cm/sec, more preferably between ~~[[10-45]]~~ 10 and 45 cm/sec and still more preferably about-between ~~[[20-20]]~~ 20 and 40 cm/sec. The total gas superficial velocities inside the mixing tank may be different than the velocity of the reactant gas mixture entering the reaction zone because of possible path restrictions (as illustrated in Figure 2) or expansions (not shown) between the mixing tank and the reaction zone, which may accelerate or decelerate the reactant gas velocity from the mixer tank to the reaction zone.

[0053] The diameter of a mixing tank may be determined from the diameter of a corresponding reaction zone, the velocity for the reactant gas entering the reaction zone, and the superficial velocity of the gas in the mixing tank, assuming conservation of reactant gas volumetric flow

between the mixer tank outlet and the reaction zone inlet. These variables are related by the equation:

$$4 \pi (D_r)^2 V_{rg} = 4 \pi (D_t)^2 V_g \quad \underline{4 \pi (D_r)^2 V_{rg} = 4 \pi (D_t)^2 V_g}$$

where :

Dt = tank diameter ; Dr = reaction zone diameter ; Vrg = velocity of reactant gas entering the reaction zone (i.e. 3-6100 cm/sec); Vg = superficial velocity of gas in the mixing tank (i.e. 5-60 cm/sec); $[\pi =] \pi \approx 3.14$

Therefore, $D_t = D_r \cdot \text{square root} (V_{rg} / V_g)$

[0054] As the turbulence in the liquid increases, the collisions and coalescence/breaking events between bubbles are increased, leading to increased mixing. High liquid turbulence also tends to break-up larger bubbles and leads to a smaller average bubble size in the liquid. A preferred flow regime in the mixer tank is characterized by a churn-turbulent flow regime, wherein the total gas superficial velocity (corresponding to the combined gas flows) is between about 10 cm/sec and about 60 cm/sec. In the churn-flow regime, the gas-induced liquid turbulent flow should be sufficient to mix the plurality of gases. The use of mechanical devices, static structure, ~~and/or~~ and/or gas recirculation may be used, but should not be necessary. When the total gas superficial velocity is less than about 10 cm/sec, the flow in the mixer tank can be characterized by a bubbly flow regime. In the bubbly flow regime, the gas-induced turbulent flow may not be sufficient to mix efficiently the plurality of gases; therefore it might be necessary to increase the liquid turbulence in at least a portion of the liquid by using at least one mechanical device such as a powered device, at least one static structure, and/or a gas recirculation loop in order to increase the total gas flow (i.e. the total gas superficial velocity) entering the mixer tank to increase bubble interactions, hence gas mixing. When the total gas superficial velocity is greater than about 60 cm/sec, the flow in the mixer tank can be characterized by a slug flow regime. In the slug flow regime, the gas-induced turbulent flow may not be sufficient to mix the plurality of gases; therefore it might be necessary to increase the liquid turbulence in at least a portion of the liquid by using static structures, such as packing material, at least one baffle, at least one perforated plate, and the like to increase bubble interactions. The liquid turbulence can be characterized by a Reynolds number greater than 20, preferably greater than 200. Alternatively,

the flow pattern of the gas phase in the bubble mixer tank can be described by the gas superficial velocity and the gas Peclet number (Pe^G), which has the form $Pe^G = U_G L/D_G$, where U_G is the superficial gas velocity, L is the gas-expanded liquid height in the tank, and D_G is the gas dispersion coefficient. The gas dispersion coefficient is a function of the superficial gas velocity, gas holdup, and the tank diameter. The gas flow is preferably characterized by a gas Peclet number greater than 0.1, preferably greater than about 1, still more preferably greater than about 5.

[0055] While some liquid turbulence is preferably induced by the injection of the feed gases, it may be desired to create additional turbulence within the liquid. The turbulence induced by gas flow may be supplemented by the help of a powered mechanical device, a recirculation loop for the gas, at least one static internal structure, or combinations thereof. For example, if the flow rate-total gas superficial velocity is too low to cause a sufficiently turbulent liquid flow regime, then other additional means for creating the liquid turbulent flow may be needed. The powered mechanical device may comprise at least one paddle, at least one stirrer, at least one impeller, at least one propeller, or combinations thereof. The static internal structure may comprise at least one baffle, at least one partition plate, a packing material, a heat-exchange device, or combinations thereof. Figures 6 – 8 and 11 illustrate some possible techniques for creating additional turbulence within the liquid, namely mechanical stirrers (shown on Figure 6), partition plates (shown on Figure 7), fluid circulation systems, such as external gas recirculation with the use of a compressor (shown in Figure 8) or an internal liquid recirculation with the use of a downcomer tube (not shown), and a packing material such as a random packing material (shown in Figure 11) or a structured packing material (not illustrated).

Please replace the paragraph [0060] on Page 15 of the specification as filed with the replacement lines set out below.

[0060] Referring now to Figure 10, a catalytic oxidation system 150 includes a gas-induced liquid-turbulent mixing region 155 and a reaction region 160 comprising a catalyst 180, both regions being integrated into a single vessel 165. A hydrocarbon gas stream 170 and oxidant gas

stream 175 are injected into the mixing region 155. The feed gas streams are mixed as they move through the liquid in mixing region 155 such the desired reactant gas exits the top of the gas-expanded mixing region 155 and enters ~~reactor~~-reaction region 160. In ~~reactor~~-reaction region 160, the reactant gases contact catalyst 180 and react to form product gases that exit vessel 165 through outlet 185. Mixing region 155 may include a means for increasing liquid turbulence for improving the mixing characteristics of the mixing region 155 or means for supplying heat in order to deliver the reactant gas at the desired temperature. It should be understood that, even though the reaction zone (reaction region 160) is shown comprising a catalyst 180, the oxidation system does not necessarily require a catalyst, and therefore a non-catalytic oxidation converting a reactant gas mixture without a catalyst is a suitable alternate embodiment of the oxidation system 150.

Please replace the first 5 lines of paragraph [0064] on Page 17 of the specification as filed with the replacement lines set out below.

[0064] The synthesis reactor using syngas as feedstock is preferably a Fischer-Tropsch reactor. The Fischer-Tropsch reactor can comprise any of the Fischer-Tropsch technology and/or methods known in the art. The hydrogen to carbon monoxide ratio in the feedstock is generally deliberately adjusted to a desired ratio of between 1.4:1 ~~to~~ and 2.3:1, preferably between 1.7:1 ~~to~~ and 2.1:1, but can vary between 0.5:1 and 4:1. ...